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Sea Turtle Bycatch off the Western Region of the Ghanaian Coast

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Relatively little is known about the migration patterns, genetic variation or nesting behavior of sea turtles along the approximate 560-km long coast of Ghana, in West Africa (Tanner 2013). Currently, olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles are known to nest in Ghana, and hawksbills (*Eretmochelys imbricata*) are thought to have nested historically along the coast (Doak 2009). Ghanaian people in the Western Region have two words for sea turtle. "Anwa" is used specifically for leatherbacks, and "Kawula" refers to all hard-shelled sea turtles. This misinterpretation among local people that all hard-shelled sea turtles are the same species typically results in vague and unreliable documentation of sea turtle sightings. Elders of coastal villages described the beaches as being full of turtles every night during the nesting seasons in past decades (Nana Kwesi Bin 2012). Due to hunting of marine species, and coinciding with bush meat hunting, the occurrence of nesting sea turtles has declined; this has been observed by local people (Nana Kwesi Bin 2012).

Although monitoring of the nesting beaches may help clarify which species use Ghanaian beaches to reproduce, it does not capture the occurrence of all sea turtles in the country's waters. It is assumed that the four principle sea turtle species that occur in West Africa, namely the leatherback, olive ridley, green and hawksbill (Barnett *et al*. 2004), also frequent the waters of the Ghanaian coast due to their presence in nearby countries, although this has not been demonstrated to date.

Fishermen in Ghana fish for subsistence and/or commercial purposes with most fishing done by canoe boats that travel <10 km from shore (Nana Kwesi Bin 2012). This project sought to investigate bycatch of sea turtles by Ghana's fishers not only to clarify which species occur in Ghana's waters but also as an opportunity to raise awareness of sea turtle conservation within the fishing community, with the ultimate goal of reducing the likelihood of poaching.

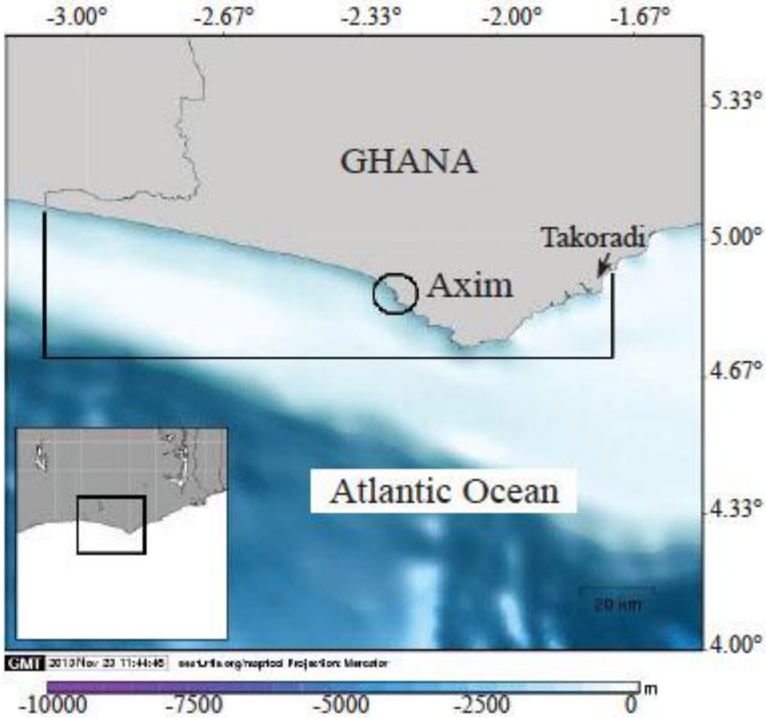

Figure 1. The study site in Ghana's Western Region. Fishing range is shown by black lines on the main map, with the town of Axim circled. The color gradient of the ocean shows the bathymetry (in meters).

This study was concentrated in Axim, which is a large fishing port in the centre of Ellembelle, in the Western Region (Fig. 1). With 800-1000 fishing canoes in the town, fishermen operate in the waters along the whole of the region's coast from Takoradi to the Ivory Coast border (Fig. 1). From 15 November to 19 December 2012 (34 days), 25 fishing teams were asked to report sea turtles encountered as bycatch in their nets. The fishermen used a mixture of gillnets, including set-round nets (which are soaked for up to 24 hours) and linear nets that are constantly attended by fishermen. This study focused on the linear nets because of the increased likelihood that the turtles encountered would still be alive. As well, it was hoped that this might encourage conservation projects in the area that are trying to reduce the use of round-nets as a way of reducing turtle deaths as bycatch. The participating fishermen were individually trained on sea turtle handling, identification and biometric data collection, including measures of curved carapace length (CCL) and curved carapace width (CCW). They were given illustrated data sheets to record location, time, species, injuries, and measurements of any sea turtles encountered as bycatch. Those fishermen with camera phones were asked to photograph the turtles before release. The use of illustrated data sheets enabled illiterate fishermen to take part in the study. As every boat must remain in the harbor for at least one day every week for cultural reasons and because effort varied widely by boat, the catch per unit effort was calculated using the amount of sea turtles caught per boat over the entire study period of 34 days.

Species	Number caught	CPUE	CCL (cm)	CCW (cm)
Olive ridley	71	2.96	61.8 ±5.6	63.8 ±4.8
Loggerhead	7	0.29	68.6 ±7.2	69.2 ±2.7
Leatherback	1	0.04	N/A	N/A
Hawksbill	1	0.04	34.3	25.4
Green	1	0.04	33.0	35.6
Unknown	3	0.13	66.5 ±2.7	64.8 ±3.1

Table 1. Number and average curved carapace length (CCL) and width (CCW) ±SD of sea turtles incidentally captured in Ghana. CPUE = average captures of turtles per boat.

Olive ridleys were the most common sea turtles reported as bycatch. With 2.96 CPUE (using sea turtles caught per boat, Table 1), olive ridleys were numerous throughout the study, being consistently caught every week. Loggerheads were also recorded, although in relatively low numbers compared to olive ridleys, and all captures occurred within the first nine days of the study. One hawksbill, one leatherback and one green turtle were also captured (Table 1).

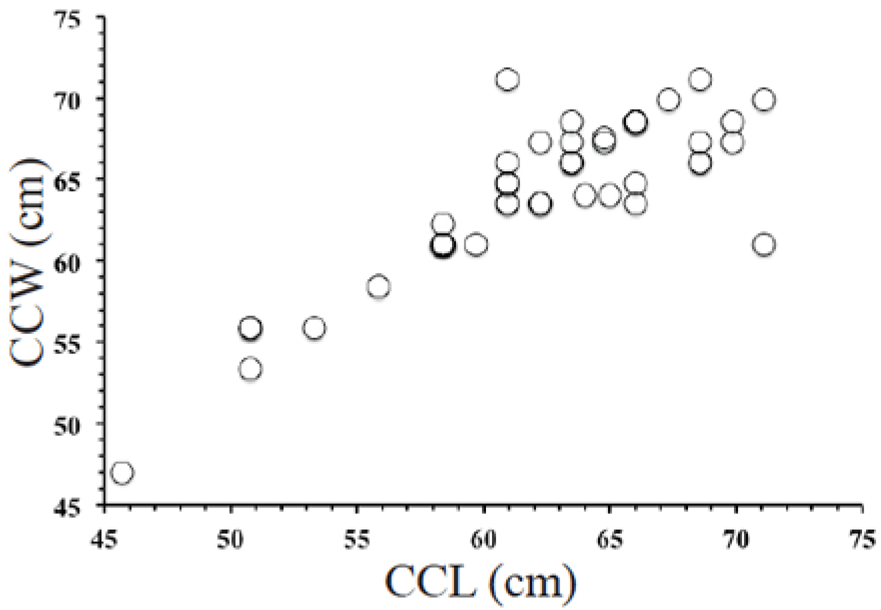

Figure 2. Curved carapace length (CCL) and curved carapace width (CCW) of olive ridleys captured. Data from 54 turtles with biometric data are plotted; note that some points overlap and are indiscernable.

The average size of the olive ridleys captured was 61.8 ± 5.6 SD cm CCL (Table 1), which roughly corresponds with the estimated global reproductive average of 66.0 cm CCL (Spotila 2004). The smallest olive ridley captured (45.7 cm CCL and 47.0 cm CCW; Fig. 2), was likely an immature turtle. There was also an olive ridley reported with measurements of 90.2 cm CCL and 91.4 cm CCW, which suggests it was an unusually large olive ridley. The photograph for this turtle showed that it had olive ridley characteristics, but species could not be conclusively determined. Therefore, data for this animal are not included in the summary tables or figure. The single hawksbill captured was 34.3 cm CCL and 25.4 cm CCW, while the one green turtle captured was 33.0 cm CCL and 35.6 cm CCW. Both these turtles are smaller than the average reproductive size for the species in the Atlantic (Chaloupka *et al*. 1997; Luke *et al*. 2004; Spotila 2004). Unfortunately, due to the large size of the leatherback, fishermen were unable to bring it aboard their canoe boats to collect measurements (Table 1). The larger values for CCW in comparison to the CCL values are surprising, as in other studies these species of turtles has been measured with CCL values greater than CCW (e.g. Shanker *et al*. 2003). This may reflect issues in the data collection, rather than abnormalities in the turtle population.

Species	West of Axim	Outside Axim	East of Axim	Unknown location
Olive ridley	21	23	0	27
Loggerhead	1	1	0	5
Leatherback	0	0	0	1
Hawksbill	1	0	0	0
Green	1	0	0	0
Unknown	0	0	0	3
Total	24	24	0	36

Table 2. Regions in Ghana where turtles were reported captured.

For the captures with known locations, half were from the coast west of Axim between the town and the border with the Ivory Coast (Table 2). No captures were recorded from the coast east of Axim. This may be because more fishing boats travel to the west than to the east. To the east of Axim is the large town of Takoradi where large commercial fishing vessels are located; these vessels reportedly use illegal means of fishing such as light and explosives. These fishing methods disrupt fishing activities for the canoes of Axim, so the fishermen tend to avoid commercial boats, and Takoradi. To the west of Axim there are no large towns and thus there is less competition for fish. More information would be needed to confirm whether this is the actual reason for the lack of sea turtle captures in this area, or whether sea turtles are absent from the waters surrounding Takoradi.

Olive ridleys are the most abundant turtle species in the region, nesting throughout West African countries, and some are occasionally resident in the Gulf of Guinea (Barnett *et al*. 2004; Formia *et al*. 2003; Formia *et al*. 2007; Fretey & Malaussena 1991; Fretey *et al*. 2007; Tomas *et al*. 2010; Weir *et al*. 2007). The Gulf of Guinea does occasionally support immature olive ridleys (Formia *et al*. 2003; Formia *et al*. 2007), although most stay in pelagic areas for their entire development (Luschi *et al*. 2003). With these preliminary data on bycatch, it cannot be confirmed if the individuals we observed were feeding, reproducing, residing, or simply migrating through the area. The CPUE data are based on the number of boats participating in the study, and suggest that the interaction between an individual canoe and sea turtles is relatively low. However, if these bycatch rates from Axim are extrapolated to all the fishing communities along the entire coast, the severity of the problem becomes more apparent.

Interestingly, loggerheads were found more frequently than expected (Table 1). Unfortunately, it was not possible to place metal flipper tags or PIT tags on captured and released animals, meaning some loggerheads may have been recaptured in this study. However, four loggerheads were captured on one boat at one time, confirming that they do have a presence in Ghanaian waters. Although loggerheads are abundant in some countries in Atlantic Africa (Formia *et al*. 2003; Tomas *et al*. 2010; Weir *et al*. 2007), both for nesting and for feeding, relatively little is known about their feeding area in the region (see Monzón-

Argüello *et al*. 2010). Currently, there are few records of any sea turtle activities in the Ivory Coast and Liberia due to political instability, which limits the research that can be undertaken by conservation organizations (Formia *et al*. 2003). It is possible that there are greater numbers of loggerheads feeding along the coast of Central Western African countries than previously thought, which would be an important area to establish conservation efforts, especially with the oil construction escalating in the region. There are known loggerhead foraging areas from Mauritania to Sierra Leone, including within coastal reefs (Monzón-Argüello *et al*. 2010), and there is an offshore reef about 10 km from the Ghanaian coast. Many fishermen prefer to fish in that area, especially in calm weather, presumably because it has a greater abundance of fish. According to boat owners, this reef extends to where oil rig construction is underway, and where the water depth increases substantially (Nana Kwesi Bin 2012). It would be useful to investigate unmonitored beaches using GPS to confirm whether loggerheads are nesting or whether they are simply residing offshore. A tagging program would also be useful to investigate how many individuals of each species are present, although this would require constant communication among amateur conservationists, small conservation groups and the government to extend tagging across the Western Region's coastline (nesting and in-water).

The low rate of leatherback bycatch is interesting (Table 1). The nesting season for leatherbacks in Bioko, in the Gulf of Guinea, runs from November - February, with a peak from December - January (Tomas *et al*. 2010). It is likely that the leatherback nesting season is similar in Ghana, thus there should have been reproductive leatherback females in the coastal area during the study period. Indeed, leatherbacks were observed nesting every week during the study period on the coast west of Axim (J. Flynn unpubl. data). As there were some turtles traveling close to shore for nesting, we expected to see them caught by the canoe fishermen (Luschi *et al*. 2003; Spotila 2004). A possible reason for the lack of documented leatherbacks is that fishermen were fearful of reporting leatherback information due to the greater enforcement of laws against leatherback poaching in Ghana. Although the take of any marine turtle is illegal under the Ghana Wildlife Regulations Act of 1974 (Doak 2009) and illegal poaching continues (Tanner 2013), the protection of leatherbacks is enforced more regularly than the protection for hard-shelled sea turtle species (Nana Kwesi Bin 2012).

The hawksbill and green turtles captured were juvenile-sized animals. The Gulf of Guinea, in the waters surrounding Ghana, is an important habitat for both adult and immature sea turtles, with juvenile greens and hawksbills foraging in the area throughout the year (Formia *et al*. 2003; Formia *et al*. 2007). The coastal habitats off Cameroon and Equatorial Guinea are significant developmental habitats for hawksbill juveniles (Monzón-Argüello *et al*. 2011). It is likely that the individuals caught were residents in feeding or developmental habitats in and around the Gulf of Guinea. The local fishermen claim to catch many juvenile sea turtles (Nana Kwesi Bin 2012), further supporting the importance of the Gulf of Guinea as a foraging habitat.

There were a few shortcomings in this study, which could be improved in future work, by positively identifying species, reducing transcript errors, and by using a longer period of study, with more detailed information collected on fishing effort per boat. Preferably, future studies should run for a whole year, to account for any potential seasonality of species occurrence in the area. A concomitant comprehensive beach survey would be useful for identifying which species are nesting in the area and when nesting is most common. Although all fishermen were trained sufficiently, there were 25 different canoe crews taking measurements, and all were new to this type of data collection. However, without their participation, these important data would not have been collected. By comparing photographs to the species recorded by the fishermen, it was noted that only a minority of fishermen were consistent in positive identification, so any turtles without photographs had to be labelled as "unknown." The data recorded over the study period suggest that five sea turtle species (leatherback, olive ridley, loggerhead, green and hawksbill) occur in the coastal waters of Ghana, with olive ridleys being the most common.

Ghana is a country previously overlooked in its conservation potential due to lack of information about sea turtle distribution and abundance. This study shows that Ghana may host significant numbers and diversity of sea turtle species. The country is currently investing in the oil industry, creating large oil rigs off the coast, with pipes to the refineries on the shore. As well large commercial docks are being built for oil transportation (J. Flynn unpubl. data). These practices may damage the offshore reefs and they may also limit nesting habitat on beaches that are being removed to make way for dock construction. These large scale offshore construction projects may have a large impact on sea turtles if the Ghanaian coastal waters are found to be an important forging habitat for various species within the larger Gulf of Guinea area. Continuing research in Ghana has the potential to document these effects and to improve conservation measures for sea turtles in the region.

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